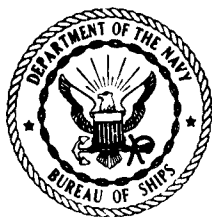
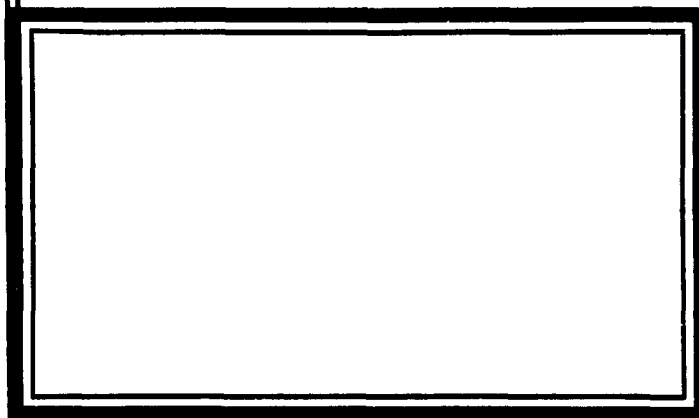


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**Puget Sound Naval Shipyard
Bremerton, Washington**

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MARINE LAMINATING PROPERTIES OF
SELECTED WOOD SPECIES: OUTDOOR EXPOSURE
ALASKA YELLOW CEDAR
(Chamaecyparis nootkatensis)
WESTERN LARCH (Larix occidentalis)
(BuShips Index No. SRO07-03-02)
(Identification No. 37-1004-2)
Progress Report E-412-L3
June 1963

by
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PUGET SOUND NAVAL SHIPYARD
Bremerton, Washington

PUGET SOUND NAVAL SHIPYARD
QUALITY ASSURANCE DIVISION

Progress Report E-412-L3

Subj: Marine laminating properties of Alaska yellow cedar and western larch; outdoor exposure (BuShips Index No. SRO07-03-02, Task 1004, Identification No. 57-1004-2)

Ref: (a) BUSHIPS ltr All/NS-032-001 (345B) Ser 345B-227 of 31 Jul 1958
(b) BUSHIPS ltr SRO07-03-02 Ser 634C3-632 of 8 Aug 1962
(c) NAVSHIPYDBREM MAT LABS Progress Report E-412-15 of Dec 1961
(d) NAVSHIPYDBREM MAT LABS Progress Report E-412-16 of Jan 1962
(e) NAVSHIPYDBREM MAT LABS Evaluation Report E-412-L2 of Jul 1962
(f) Military Specification MIL-A-397B of 3 Feb 1953
(g) Military Specification MIL-W-2038C (SHIPS) of 26 Oct 1960
(h) Military Specification MIL-W-0015154C (SHIPS) of 15 May 1961
(i) NAVSHIPYDBREM MAT LABS Final Development Report E-412A of May 1960

Summary

Wood laminates of Alaska yellow cedar and western larch, adhesive bonded with three commercial phenol resorcinol formaldehyde adhesives meeting MIL-A-397B, cured at 150° to 154°F. for 6 hours (center glue line temperature), are exposed to outdoor weathering for durability study. Evaluations at 10 to 11 and 17 to 18 months show higher glue line delamination than observed after 4 to 5 months exposure. The Alaska cedar laminates show considerably more delamination than larch laminates. Outdoor exposure is developing greater delamination than either the presently specified 12-day test or a proposed 3-hour test, but the laminates are still considered to be in satisfactory condition.

1. Background

Natural weathering exposure evaluations have been made periodically on a series of domestic, foreign and treated wood laminates as authorized by references (a) and (b). Results of continued exposure of Alaska yellow cedar after 11 and 18½ months and of western larch after 10 and 17½ months are now reported. Previous results of initial evaluations of exposure tests

on cedar after 5 months, on larch after $4\frac{1}{2}$ months, and on other species up to two years were reported in reference (e).

2. Materials

a. Alaska Yellow Cedar (*Chamaecyparis nootkatensis*)

The lumber was procured by Shipyard purchase from a local lumber yard which obtained the lumber from a Seattle wholesaler. The lumber originated in southeastern Alaska. Details of laminate fabrication, results of the standard 12-day delamination test, block shear test and a proposed 3-hour test were originally reported in reference (c).

b. Western Larch (*Larix occidentalis*)

The larch lumber, provided by Anaconda Company (Lumber Division), was cut from old growth trees grown near Bonner, Montana. Details of fabrication, 12-day, block shear and 3-hour tests are contained in reference (d).

c. Adhesive Bonding

Three marine service resorcinol-phenol-formaldehyde laminating adhesives conforming to Class 2 of reference (f) were used. The lumber was at 11 to 13% moisture content when glued. Each laminate was composed of six laminations $\frac{3}{4}$ -inch thick, 6 inches wide and $\frac{4}{7}$ inches long. Curing consisted of heating the clamped laminates at a chamber temperature of 170 to 175°F. to give a center glue-line temperature of 150 to 154°F. for six hours. The laminating procedures were essentially as required by MIL-W-2038C and MIL-W-0015154C, references (g) and (h) respectively. Clamping pressure was 150 ± 25 p. s. i. for cedar and 175 ± 25 p. s. i. for

larch. Chamber temperature was cut back to maintain the desired glue-line temperature as described in Report E-412-A, reference (1).

3. Results of Tests

Results of outdoor weathering delamination evaluations for each period of exposure of the two species are shown in Table I by individual laminates within a species. For comparison, the results of the standard 12-day and the 3-hour test of reports, references (c) and (d) are included. Results show that of these two species fabricated under nearly identical conditions, Alaska yellow cedar has been affected more than larch by continued exposure to outdoor weathering. The 12-day and 3-hour test results did not show the differences in delamination quality between the two species as well as the outdoor exposure.

4. Discussion

Delamination has continued to increase, but the rate of change has decreased since the previous evaluation period. After 18 months outdoor exposure, laminates of Alaska yellow cedar have developed considerably more delamination, and western larch slightly more delamination, than other species of similar density, Khaya, Central American mahogany and Philippine mahogany (red lauan) and two heavier species, Kokrodua and Angelique, reported in reference (e).

5. Conclusions

Based on 18 months outdoor exposure results reported herein, it is concluded that laminates of Alaska yellow cedar and western larch made

Progress Report E-412-L3

according to MIL-W-2038C or MIL-W-001515C should be satisfactory for marine service use. It should be noted that the order of percent delamination in outdoor weathering should be expected to be higher than the acceptance limits based on present specification accelerated testing.

6. Future Work

The outdoor exposure of these specimens is continuing. The two-year evaluation will be in October, 1963.

TABLE I - DELAMINATION DEVELOPED IN LABORATORY TESTS AND OUTDOOR EXPOSURE

Species	Adhesive	Beam No.	Closed Assembly Period, Minutes	Test Method					
				12-Day * Third Cycle	3-Hour **	Outdoor Exposure ***			
						5 Mo.	11 Mo.	18-1/2 Mo.	
				Delamination, %					
Cedar, Alaska Yellow	A	95	45	0.1	0.0	1.1	5.8	9.3	
		96	5	0.1	0.5	4.1	12.0	13.6	
	B	94	70	0.8	1.0	8.5	16.9	21.3	
		93	26	0.7	0.8	5.1	10.4	13.0	
	C	91	90	0.4	1.4	1.2	6.9	10.5	
		92	16	0.9	1.9	4.6	9.6	11.5	
	Av.			0.5	0.9	4.2	10.3	13.2	
	Larch, Western	A	101	45	0.1	0.0	0.7	1.8	2.0
			102	5	0.0	0.0	1.1	1.3	1.6
		B	99	70	0.6	0.0	2.9	3.8	4.1
100			15	1.1	0.0	3.4	4.0	4.2	
C		97	90	0.5	0.0	0.7	0.7	1.2	
		98	15	0.2	0.0	1.2	1.2	1.5	
Av.			0.4	0.0	1.6	2.1	2.4		

* Average of 3 specimens per beam of 5 gluelines (15 values)

** Average of 2 specimens per beam of 5 gluelines (10 values)

*** Results of 1 specimen per beam of 5 gluelines (average of north and south face)

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